CASE STUDY ON OPEN SOURCE HEALTH CARE SYSTEMS IN NEPAL

MINIPROJECT FOR THE COURSE COMP 401 : SOFTWARE ENGINEERING

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—The enjoyment of the highest attainable standard of health is one of the fundamental rights of every human being without distinction of race, religion, political belief, economic or social condition

WHO, 1989

1

INTRODUCTION

As remarked in the Constitution of the World Health Organization [1], Health is a fundamental and non unalienable right. The health sector thus must aspire to reach every individual and provide service to the highest of standard possible. Information technology has been a boon in attaining this goal by aiding humans in all the aspects of providing health care.

1.1 Background

Health Care Systems usually refers to the software and its related data that are in some way linked to human health and treatment. It is usually deployed by health care providers like hospitals and clinic or nation states. C. Becchetti and A. Neri (2013) [2] define medical software as :

- a stand alone software used for medical purposes (diagnostic or therapeutic)
- a software component of a medical device (i.e., embedded software)
- a software which drives a device or influences the use of a device

- a software that is an accessory of a medical device.

In addition to this, it is essential that there are **standards** to store the data, **protocols** to communicate it and international agreement on the method and guidelines to share it amongst various stakeholders all over the globe. Global Health crisis like pandemics make this need apparent as noted by K. Kadakia et. al [3]. '... the onset of the COVID-19 pandemic has dramatically and rapidly increased the value proposition of digital health, with unprecedented adoption and utilization of new software tools and digital platforms by payers and providers to meet patient needs during the public health emergency.'

1.2 Methodology

The primary methodology for this case study was literature review. Since all the software and standards are in open source, extensive resources about these are available online. However, there were issues getting data for Nepal because the data is not readily available online while a large part of the implementation details are never shared and just circulated amongst the employess in the institutions and ministries.

2
Selected Cases

In this chapter, we will explore the five medical systems as representatives. Along with a quick overview of the technical aspects, the current and potential use case in Nepal will also be discussed. The suggestations and conclusion for each is also mentioned

2.1 DHIS2

2.1.1 Introduction

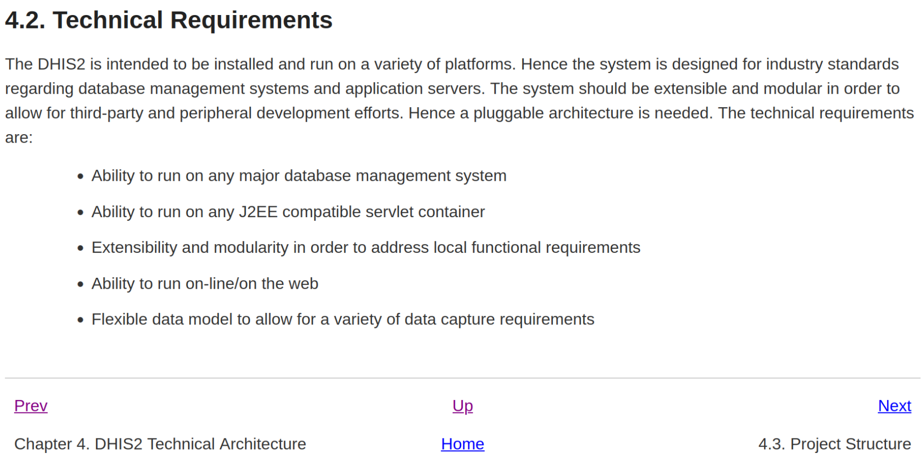
The health policy of any country must be backed up by data. The data about its citizens and even the entire globe as a whole is crucial for the planning and preparedness in the face of health crisis and also to aid an gradual progression to quality health and living. The leading open source tool to aid the collection and analysis of health data at a huge scale is DHIS2. DHIS2 stands for District Health Information Software.

It is developed and maintained by Health Information Service Provider (HISP) at University of Oslo. The foundation defines DHIS2 as, "..IT system for collecting, validating, analyzing and presenting data for health information management activities."[1].

2.1.2 Technical Aspects

Requirements

In the documentation[2], the Technical requirements are laid out in figure 2.1:



4.2. Technical Requirements

The DHIS2 is intended to be installed and run on a variety of platforms. Hence the system is designed for industry standards regarding database management systems and application servers. The system should be extensible and modular in order to allow for third-party and peripheral development efforts. Hence a pluggable architecture is needed. The technical requirements are:

- Ability to run on any major database management system
- Ability to run on any J2EE compatible servlet container
- Extensibility and modularity in order to address local functional requirements
- Ability to run on-line/on the web
- Flexible data model to allow for a variety of data capture requirements

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Figure 2.1: Technical Requirements of DHIS2

Additional Services Provided

Since, DHIS2 is intended for state-level actors, WHO makes it easy to start, transition and maintain DHIS2 by providing[3] :

- **D2-docker**

  Docker images to easily deploy the application keeping track of all the customization the country needs.

- **MetaData Sync App**

  it facilitates the installation of modules and defining the headers for the tables and other properties.

- **Training App**

  DHIS2 is challenging to use without training and guidance and the quality of data will also degrade if not used correctly. Thee training app is especially built for countries to build capacity to utilize DHIS2 to its full capacity.

  Legacy systems or new integration may still be using spreadsheets, The bulk load module allows for quick and easy import of large quantity of excel sheets.

webportal

WHO maintains WIDP, which is integrated database of Member State's efforts and status on managing and preventing malaria, hepatitis and various neglected tropical diseases

The portal, with sufficient credentials, can be accessed at https://extranet.who.int/dhis2/dhis-web-commons/security/login.action

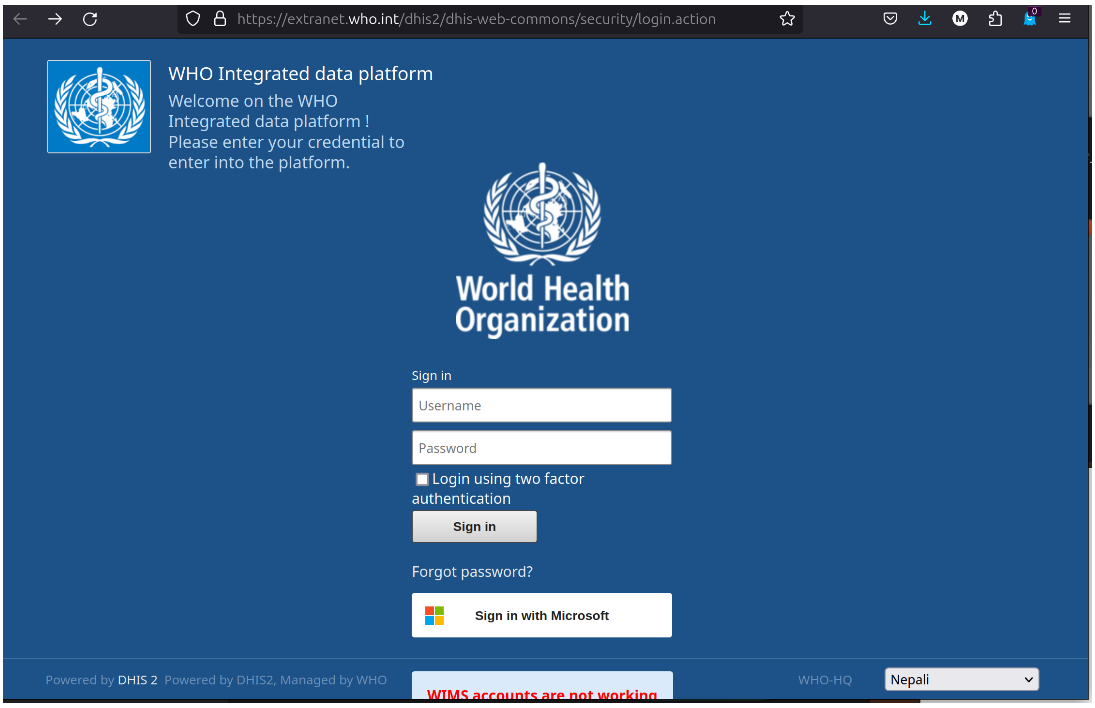

Figure 2.2: DHIS2 portal for WIDP

Architecture

lisence

The source is completely open and provided with a BSD license at https://github.com/dhis2

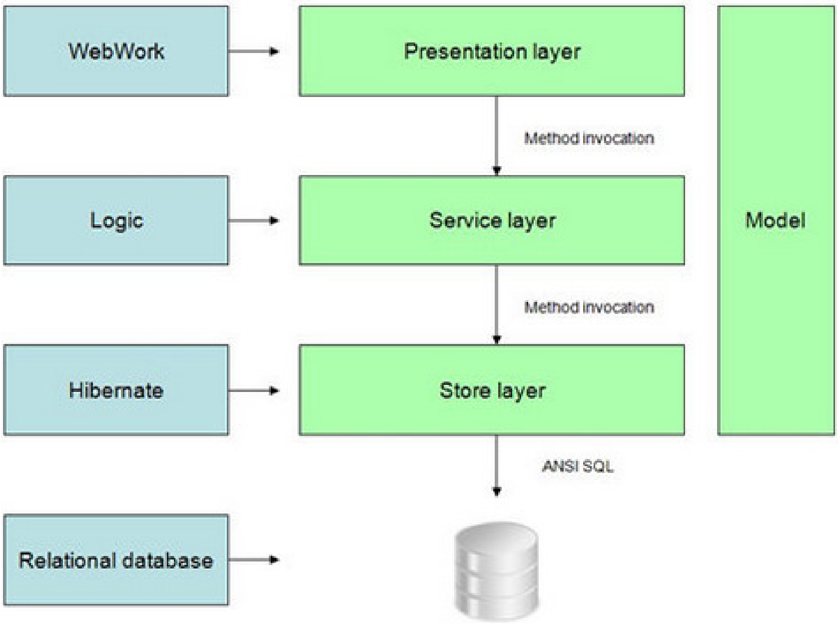

Figure 2.3: Three Tier Architecture of DHIS2

2.1.3 Use in Nepal

Although discussions about adoption started in 2011 A.D., the Health Management Information System (HMIS) based on DHIS2 was customized and planned to be rolled out from fiscal year 2073/74[4]. Currently Nepal utiizes DHIS2 to deploy a Early Warning and Reporting System (EWARS)

Figure 2.4: DHIS2 Dashboard for Nepal

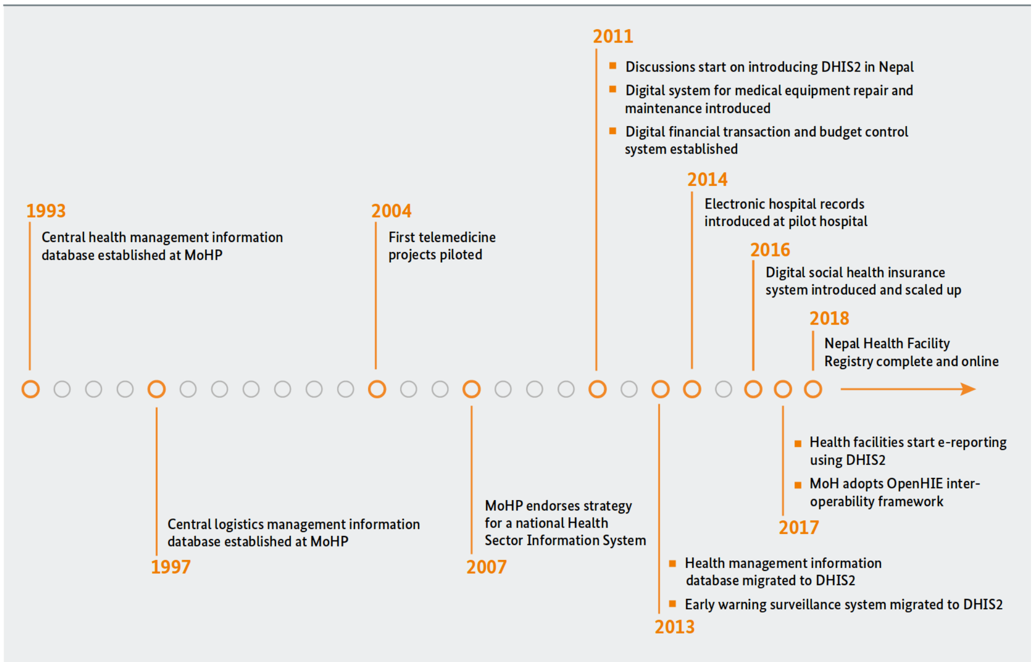

Figure 2.5: Timeline of Adoption of DHIS2 in Nepal [5]

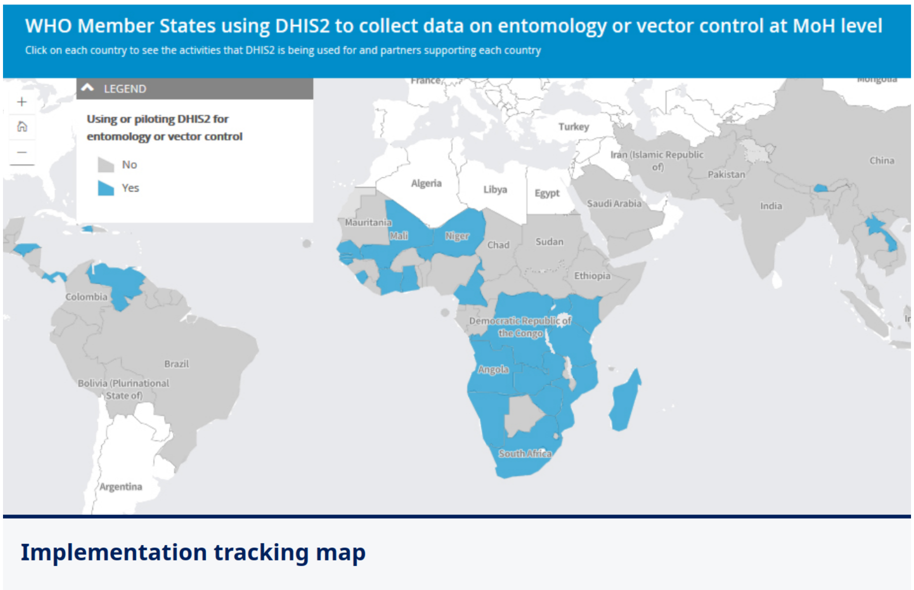

Figure 2.6: Map Showing countries that have implemented DHIS2

2.1.4 Conclusion

DHIS2 is a well integrated into the health ecosystem of Nepal. It has been playing a crucial role in management of data related to all aspects of health. It has also been beneficial to communicate research and integrate the lessons derived from world's context in the health scenario of Nepal.

References for DHIS2

[1] *Home - HISP Centre*. https://www.mn.uio.no/hisp/english/index.html. (Visited on 12/16/2023).

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2.2 openMRS

2.2.1 Introduction

Open Medical Record System (OpenMRS) is the foundational, electronic medical record technology that is developed by and maintained by a group of talented individuals and generous organizations to develop customised medical record management system for countries that serve millions of patients throughout the world.

2.2.2 Technical Aspects

architecture

The architecture of OpenMRS is tired with three layers:

- Database Layer
- Service Layer
- Presentation Layer

The function and tools used are mentioned in the image below by the openMRS foundation itself[1].

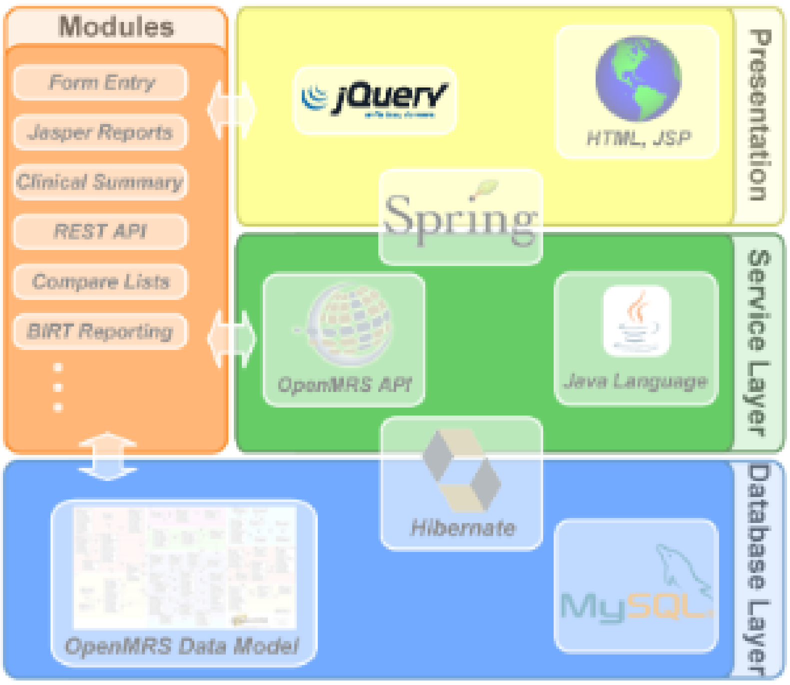

Figure 2.7: Architecture of openMRS

Modules

Moreover, it is divided into two parts, further aiding modularization to aid development.

- OpenMRS Core
- OpenMRS Add-ons

2.2.3 Use in Nepal

As per the official statistics provided by the OpenMRS foundation, Nepal is one of the 80 countries currently utilizing OpenMRS.

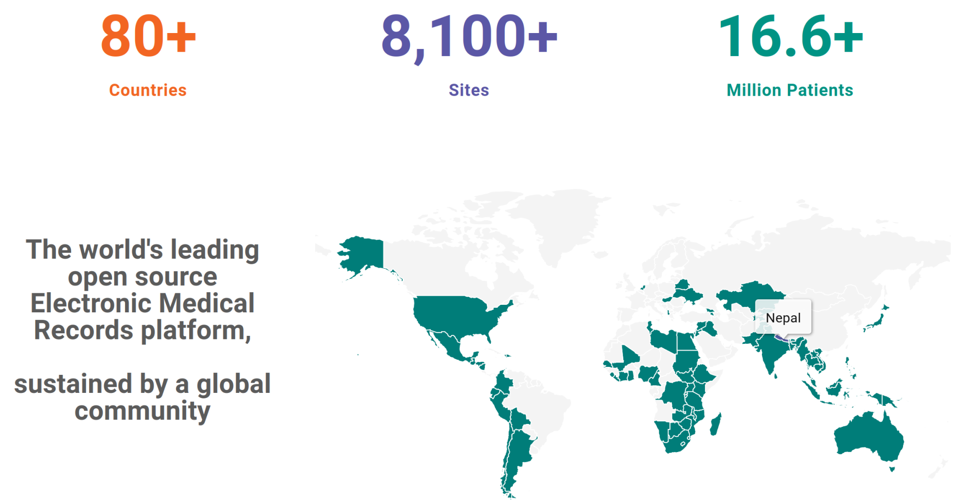

Figure 2.8: Map illustrating Countries that utilize OpenMRS

The National Innovation Center(NIC), led by Dr. Mahabir Pun has helped in the implementation of Electronic Record system based on OpenMRS[2] around Nepal namely in:

- **Dhulikhel Hospital**
  Dhulikehel hospital is using the OpenMRS based EMR for the covid patient who are isolated in the home. Dhulikhel hospital care provider provide the tele consultation and engage with patients to understand the condition of the covid symptoms. All the indicators are captured during the outbound calls initiated by the hospitals and patient take the advantage of having the conversation without visiting the hospital.
- **Chitwan aged home care** Chitwan Aged Home Care, Devghat is a continiois care home that houses 28 elderly citizens (9 men and 19 women). [3]. There is a monthly camp organized to take care of the health of the elderly residing there. It is

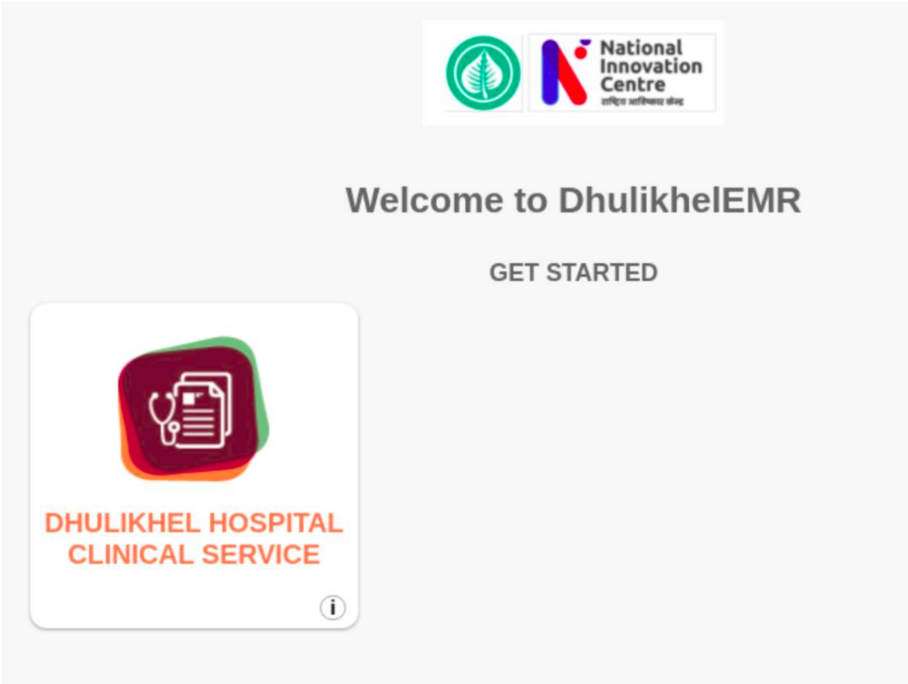

Figure 2.9: Custom Implementation of openMRS for Dhulikhel Hospital

important that the medical history is well maintained and updated to ensure proper health of the aready fragile elderly. OpenMRS has been implemend by the help of NIC to faicilate in this task.

- **Trishuli Hospital** Based on the data provided by NIC, Trishuli Hospital, which is an government district Hospital, processes 200+ OPD patients are treated using the OpenMRS system.

Apart from this, in the survey by J. Espinoza[4] which was published in 2023, here are atleast 13 implementations of OpenMRS in Nepal and the number is only going up from here.

2.2.4 Conclusion

The layered architecture of OpenMRS is vital in maintaining and developing it. Once the interface have been defined and standardized,for the most part one can see the application as a assembly of three distinct parts which can be developed by different teams altogether.

The opensource nature and the vibrant and generous community is the backbone of this project. Th health institutes in Nepal are adapting this technology as digitization becomes the norm replacing the traditional hand written records.

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2.3 openIMIS

2.3.1 Introduction

Public Health is a major concern for any government. Most countries not just collect and store health information but also provide some sort of financial support. This can be in the form of social security net of state-provided insurance or aid in certain diagonisis or procedures. OpenIMIS is targeted to provide open soure solution to the administration of health financing and social protection schemes.

2.3.2 Technical Aspects

Principles

The openIMIS initiative describes its guiding principles as [1] :

- Transparency
- Interoperability
- Adaptability and learning
- Security and privacy
- Sustainability

Use Cases and User Stories

For an example of a user story that describes the use case, consider the following diagram which is provided by the OpenIMIS foundation. This describes all the various steps that a user would take to claim an insurance and hence the software must account for.

Say A person works in a company that is enrolled in the social health car3e system. the company needs to collect their information and this will be sent to the insurance company. verifiable identity card is also issued for ease in delivery of service to the right people. If the patient ever visits any hospital, they can be easily verified by the id card and processed. This process shouldn't interrupt the health examination, diagnosis and treatment. In parallel, the necessary paper work may be filed and the claim be processed by verifying Their claim is analyzed against their scheme and paying out the necessary amount.

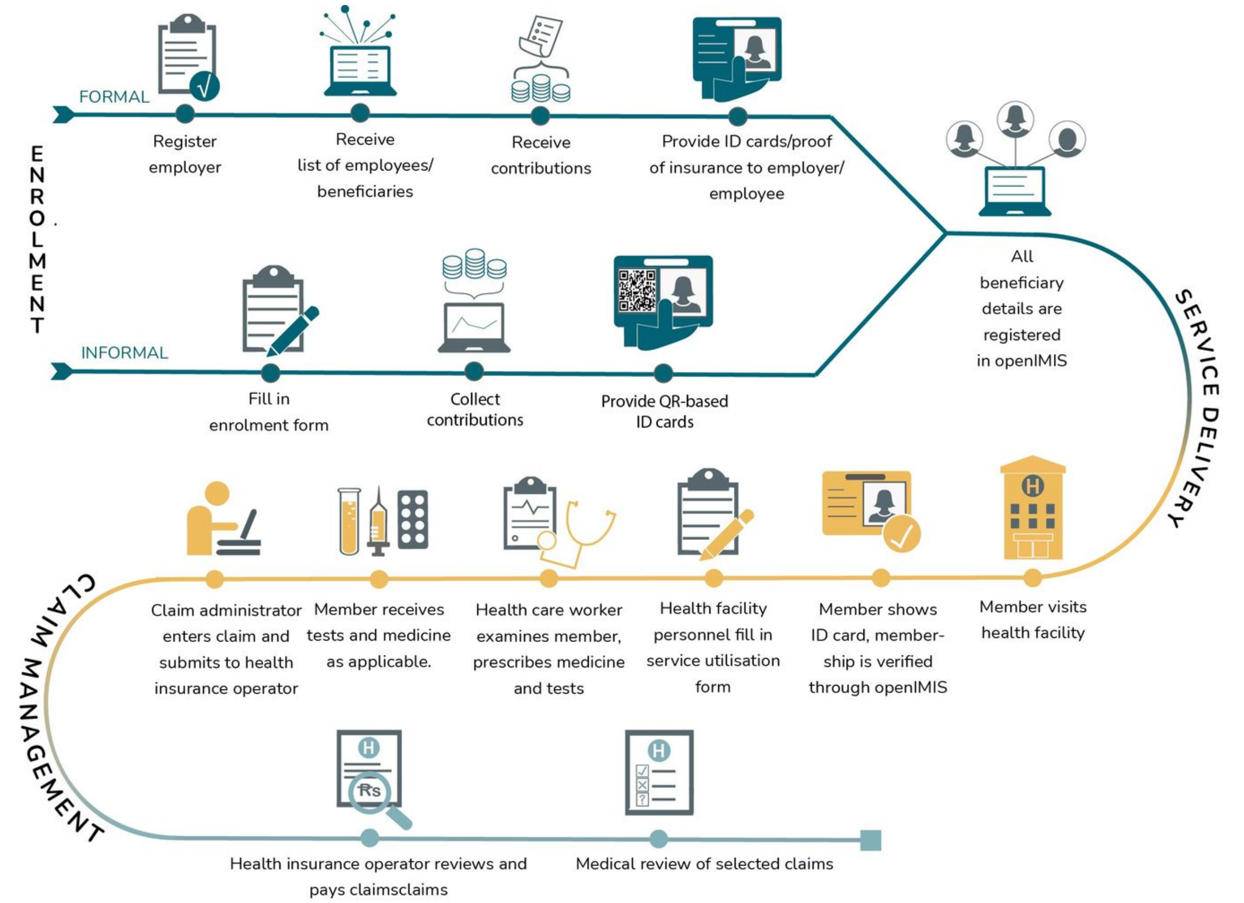

Figure 2.10: An example user story.

2.3.3 Use in Nepal

taken from [2]

In April 2016, Social health insurance was introduced by the Government of Nepal. Since its initial roll-out in three districts, social health insurance has been gradually expanded and is now available in 76 out of 77 districts of Nepal.

IMIS, adapted from the Tanzania and Cameroon implementations, was used from the very beginning to manage all core business processes of the insurance scheme, from beneficiary management to claims adjudication. The Health Insurance Board has been using openIMIS since the master version became available in 2018. [2]

The availability of Android-based apps for enrollment has meant that enrollment assistants can go door to door to bring households into the scheme. A web-based claims entry and adjudication module significantly diminishes paper-based transactions and reduces paperwork for health facilities. This has enabled the Health Insurance Board to achieve a rapid rate of expansion.

The Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)[3] and the Swiss

Tropical and Public Health Institute provide technical assistance to the Health Insurance Board for the customisation and implementation of openIMIS.

The primary focus of interoperability with openIMIS in Nepal has been around the electronic submission of claims via Electronic Medical Record Systems. There are a few service providers that use EMRs in their hospitals and work is currently underway to design standard approaches to allow them to submit claims electronically. An integration of openIMIS and Bahmni (used in 4 health facilities in Nepal) has been implemented, and is used by Bayalpata Hospital to submit claims automatically to openIMIS. Other hospitals and EMR systems are also adapting their APIs to FHIR R4 to enable digital claiming to openIMIS.

2.3.4 Conclusion

openIMIS has greatly enhanced the implementation of social health insurance in Nepal. Complicated processes, particularly around enrollment and claims processing, have been made easier.

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2.4 ICD-10

Note:

Although this case study is focused on ICD-10, the current standard as per WHO [1] is ICD-11,which was adopted by the 72nd World Health Assembly in 2019 and came into effect on 1st January 2022.

2.4.1 Introduction

International Classification of Diseases, Tenth Revision or more formally International Statistical Classification of Diseases and Related Health Problems, Tenth Revision (ICD-10) is a globally used medical classification. World Health Organization(WHO) actively maintains this list and revises it each decade. As per the website maintained by WHO [1] It is used extensively in epidemiology, health management and for clinical purposes. It is used by physicians to classify and code all diagnoses, symptoms and procedures for claims processing, researchers to standardize collection and processing data relayed to the human health and diseases and by policy makers to have a international collaboration on the response towards diseases.

Hersch et.al[2] discussed the history of ICD and traced it back to 1763 when a French physician and botanist Dr Francois Bossier de Sauvages de Lacroix developed a categorization of 10 distinct classes of diseases, which were further divided into 2400 unique diseases. Disease classification proved be a valuable resource for use by physicians and policy makers, leading to the the first International statistical Congress (1853) to develop a system of classifying causes of mortality that could be used across borders and languages.

2.4.2 Technical Aspects

ICD-10 code are alphanumeric codes that have a range of 3 to 7 characters. A 7 character code will be able to specify a disease in complete detail even including diagnostic and causative information. The general structure of the code with the parts it describes is described by the figure below.

The ICD Code can be browsed and looked for manually at:

https://icd.who.int/browse10/2019/en/XI

This website is maintained by WHO.

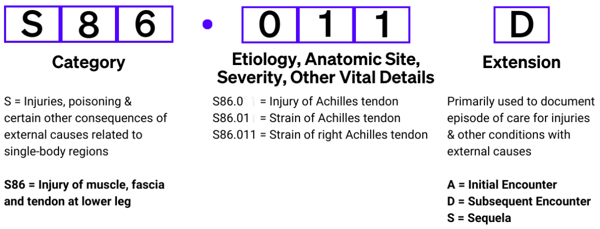

Figure 2.11: Anatomy of ICD-10 Code [3]

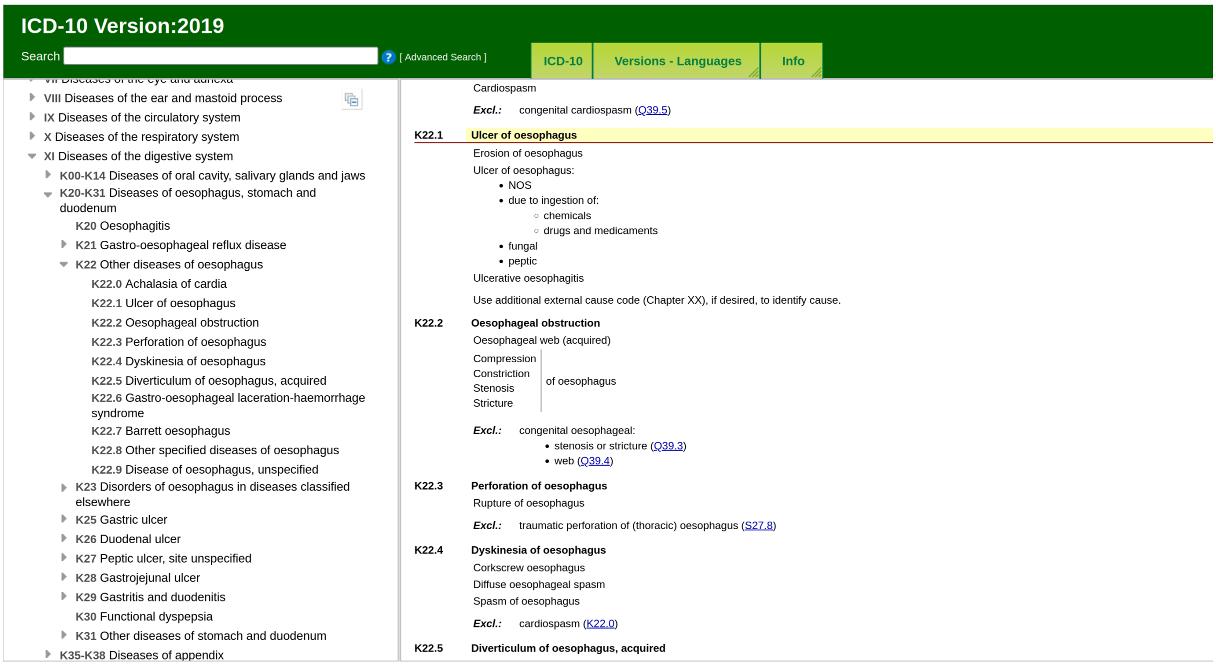

Figure 2.12: Example of Looking up the ICD-10 Code for Ulcer of Oesophagus [4]

2.4.3 Use in Nepal

Nepal's Health presents a unique set of challenges and conditions. The reporting of patient cases to global literature is greatly facilitated by the use of standardized codes. for example, the papers studying depression in geriatric patients in Nepal [5] , analysing psychiatric conditions in refugees[6] and the non communicable diseases prevalent in Nepal [7] all utilize the ICD-10 standard.

2.4.4 Conclusion

ICD-10 has been a boon in aiding global communication of health related issues and helped countries with relatively less resources to better report and benefit from the literature.

References for ICD-10

[1] *International Classification of Diseases (ICD).* https://www.who.int/standards/classifications/classification-of-diseases. (Visited on 12/14/2023).

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2.5 HL7 FHIR

2.5.1 Introduction

Health Level Seven Fast Healthcare Interoperability Resources (HL7 FHIR) is a standard developed by the non-profit HL7 to facilitate the interoperability and sa.

As per the official overview of FHIR[1], the three major challenges for health care information that were considered in building this system are :

- availability
- discoverability
- understandability
- standardization

Indeed, these are indispensable for effective and rapid patient care in the world where patients move about various places of treatment and geography. The last point about standardization is especially crucial when we want to include machine processing and eventually automated clinical decision support.

The trust and the reliability of the system also stems from the fact that HL7 is a not-for-profit, ANSI-accredited standards developing organization established in 1987. Over 50 countries, including 500+ corporate members utilize this standard. The private health sector of Nepal has also integrated this standard to both private and public health institutions during rapid covid screening.

2.5.2 Technical Aspects

FHIR's Architectural Principles

As per the official documentation of architecture of the FHIR [3] FHIR is committed to the following principles:

- Reuse and Composability
- Scalability
- Performance
- Usability

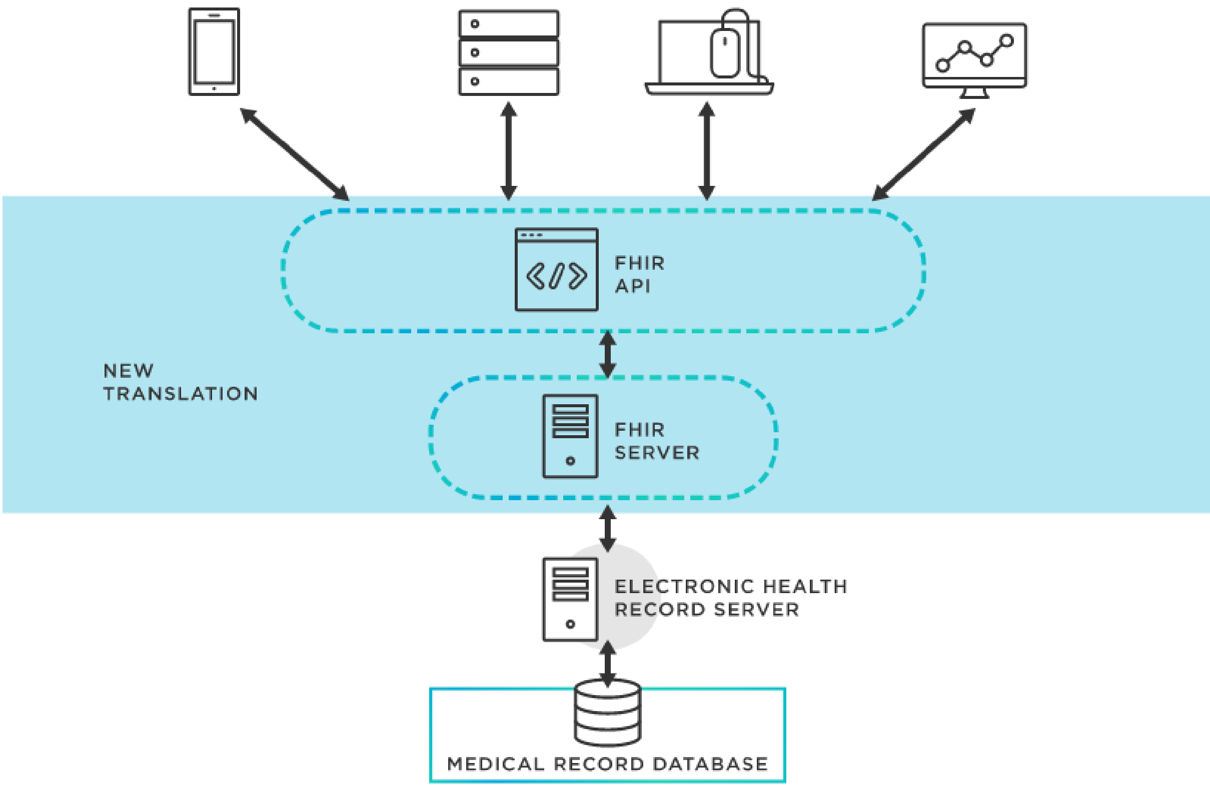

Figure 2.13: FHIR's Role in a Medical System [2]

- Data Fidelity
- Implementability

Work Division and Team Structure

The developemnt of FHIR is led by a team called the FHIR Core Work Group (FHIR)[4]. It is responsible for the development and maintenance of a delineated set of core components of the FHIR specification. It allows the development teams to work on features guides and documentation.

The entire source code is open-source and freely available at https://github.com/HL7/fhir

2.5.3 Use in Nepal

FHIR standard has been utilized in the OpenMRS systems that are present in Nepal. An explicit use case by the private sector has been in Wiseyak's easy to use Rapid Covid – 19 Screening (RCS) The company claims[5] that it will help hospitals and governments manage resources, patient load and create real-time population-level reporting for quick decision support.

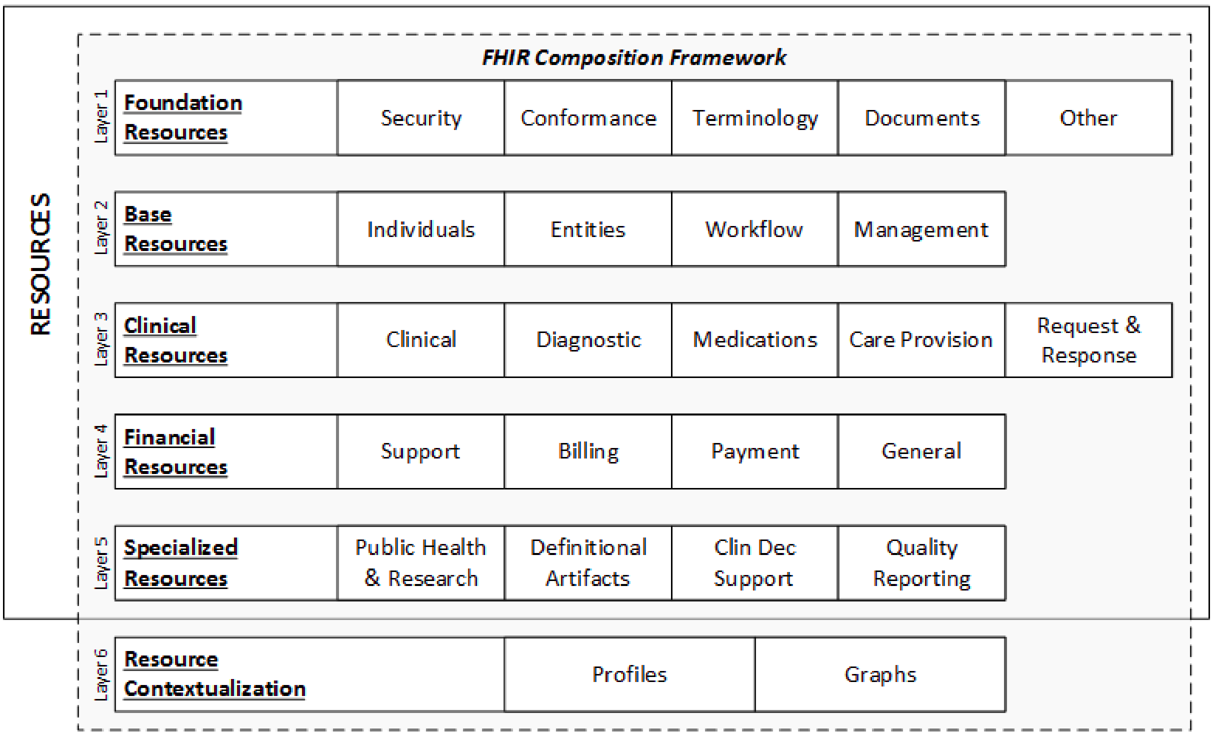

Figure 2.14: Structure of FHIR

The company mentions that, "RCS complies with FHIR and HL7 standards and produces inter-operable reports for downstream analysis."

This is a great example as this captures the essence of which the standard was set to solve. The public and private sector of a nation or even a global setting can benefit from seamless integration and collaboration using standards such as FHIR.

2.5.4 Conclusion

FHIR as a standard has been great in making the research from Nepal come to a global scale and researchers in Nepal also benefit from the global literature. The effort of experts of Nepal in updating this standard in the subsequent iterations will greatly benefit both parties.

References for HL7 FHIR

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3

Conclusions and Recommendations

OpenMRS are primarily used for managing patient records in medical practices and low-resource settings and DHIS is used for collecting and analyzing health data in resource-limited settings, particularly for national health programs. OpenIMIS helps manage social security programs and ICD-10 and FHIR are standards that help with collection, storage ans sharing of information.

Overall, Nepal is already using these systems or in the process of using these resources to some extend. The digitization of Health Sector from both public and private sector will definitely better the current scenario. The limited resources of our country can be best distributed by using open source solutions.

The overall cost of managing and providing health services will definitely be reduced by the use of open source alternatives. Moreover, it will easier to train and find capable manpower as these have been standards for a long time.

The health and IT institutes and universities have a role to play in educating, training and also contribution to these resources.

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